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Tau hadronic branching ratios

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Abstract

From the 64492 selected τ-pair events, produced at the Z^0 resonance, the measurement of the tau decays into hadrons from a global analysis using 1991, 1992 and 1993 ALEPH data is presented. Special emphasis is given to the reconstruction of photons, π^0's and the removal of fake photons. A complete and consistent description of the tau hadronic decays is presented, where up to 17 exclusive modes are measured. The new level of precision reached allows a more stringent test of $\tau - \mu$ universality in hadronic decays and more accurate measurements of the vector and axial-vector contributions to the total hadronic width.

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1 Results

From a global tau branching ratio analysis the tau hadronic decay modes are presented. A description of this analysis can be found in ref. [1]. An update with the 1993 data for the tau decays involving kaons is also given following the same prescriptions as for the previous ALEPH publications [2, 3]. This information is used to extract branching ratios of truly exclusive modes taking K^0 production properly into account. Therefore, this paper is intended to provide a complete and coherent description of the hadronic tau decays.

Mode	value (%)	σ_{total}
$B(\tau \to \pi\ \nu_\tau)$	10.90	0.18
$B(\tau \to K\ \nu_\tau)$	0.72	0.06
$B(\tau \to \pi\ \overline{K^0}\ \nu_\tau)$	0.79	0.12
$B(\tau \to K\ K^0\ \nu_\tau)$	0.26	0.08
$B(\tau \to \pi\ \pi^0\ \nu_\tau)$	25.02	0.20
$B(\tau \to K\ \pi^0\ \nu_\tau)$	0.52	0.06
$B(\tau \to \pi\ \pi^0\ \overline{K^0}\ \nu_\tau)$	0.32	0.09
$B(\tau \to K\ \pi^0\ K^0\ \nu_\tau)$	0.10	0.05
$B(\tau \to \pi\ 2\pi^0\ \nu_\tau)$	9.14	0.16
$B(\tau \to K\ 2\pi^0\ \nu_\tau)$	0.08	0.03
$B(\tau \to \pi\ \ \geq 3\pi^0\ \nu_\tau)$	1.51	0.14
$B(\tau \to 3h\ \nu_\tau)$	9.44	0.14
$B(\tau \to 3h\ \pi^0\ \nu_\tau)$	4.35	0.11
$B(\tau \to 3h\ 2\pi^0\ \nu_\tau)$	0.60	0.10
$B(\tau \to 3h\ \ \geq 3\pi^0\ \nu_\tau)$	0.20	0.07
$B(\tau \to 5h\ \nu_\tau)$	0.079	0.014
$B(\tau \to 5h\ \pi^0\ \nu_\tau)$	0.025	0.012

Table 1: Summary of the τ hadronic branching ratio measurements from ALEPH. The errors taken into account the statistical and systematic components.

$R_{\tau,V}$ and $R_{\tau,A}$

From the complete analysis of the tau hadronic branching ratios presented in this paper, it is possible to determinate the vector and axial-vector contributions to the total tau

hadronic width, usually expressed through their ratio to the leptonic width, called $R_{\tau,V}$ and $R_{\tau,A}$ respectively. The Cabibbo-suppressed contribution will be treated separately. As discussed in ref. [4] the $R_{\tau,V}$ and $R_{\tau,A}$ observables are of great interest since in their difference the non-perturbative contributions are enhanced, allowing a confrontation with the existing phenomenological models.

Modes involving a $K\overline{K}$ pair in the final state may contribute to the vector and axial-vector channels. In the following, they are equally divided into the vector and axial-vector parts with an uncertainty of 100 %. For the $\tau \to \eta\pi\pi^0\,\nu_\tau$ decay the CLEO result is used [5]. For the $\tau \to \pi K^0\overline{K^0}\,\nu_\tau$ decay rate the value $(0.3 \pm 0.15)\%$ is assumed. For $\tau \to K\overline{K}\pi\nu_\tau$ and $\tau \to K\pi\pi\nu_\tau$ fractions the values of ref. [7, 6] are used.

From the ALEPH decay rate measurements and using the complete covariance matrix the following values are obtained:

$$R_{\tau,V\,+\,A} = 3.480 \pm 0.031 \quad (1)$$

$$R_{\tau,V\,-\,A} = 0.102 \pm 0.031 \pm 0.032 \quad (2)$$

using the ALEPH $\tau \to e\overline{\nu_e}\nu_\tau$ branching ratio [1], where the first error contains the statistical and systematic contributions and the second accounts for the uncertainty in the vector-axial components of the decay rates containing a $K\overline{K}$ pair.

These results, considerably more precise than previous estimates, are in agreement with the phenomenological estimate of ref. [4] and provide additional support for the validity of a perturbative QCD description of hadronic tau decays.

References

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